Microleakage of Different Root Canal Obturation Techniques

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Summary

Leakage examination was performed using fluid transport system measuring movement of an air bubble. Tested techniques were cold lateral condensation technique, Touch`n Heat and Thermafil technique. Root canals were obturated with gutta-percha in combination with AH Plus and RoekoSeal sealers. After storing in saline solution, microleakage was measured in intervals of one month, six months and one year. The minimum microleakage values were obtained in all intervals in canals obturated using cold lateral condensation technique, while maximum values were obtained in Thermafil technique ($p< 0.05$). Significantly more leakage was found for all tested techniques in the interval of 12 months after obturation ($p< 0.05$). There was no difference between obturation quality between RoekoSeal and AH Plus, no matter what obturation technique was used.

Key words: *fluid transport system, cold lateral condensation technique, Touch`n Heat, Thermafil.*

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Introduction

Exact obturation of the whole endodontic space is the last step of endodontic treatment. The purpose of this is to avoid leakage from the oral cavity and periradicular tissues into the endodontic space, and the influence of irritants retained in the canal despite biomechanical instrumentation. Microleakage along the root canal filling could cause failure of the endodontic treatment. It is a free way for microorganisms to colonise the canal and periradicular space (1). The cold lateral condensation technique is the most used technique today. Its advantages are: relatively uncomplicated procedure, conservative preparation of root canal and material usage under control. Disadvantages are: relatively lengthy procedure and the radiographic appearance of the canal filling homogeneity is better than it is in reality (2). Thinner gutta-percha accessory cones because of their flexibility, create angulations to the main cone causing microspaces of entrapped air between the main and accessory cones. Cold lateral condensation technique is simple and effective, although other techniques have been developed with a tendency to use warmed and softened gutta-percha to achieve better contact with canal walls.

Thermafil technique is widely used today because it is simple and fast. Compared to the cold lateral condensation technique its disadvantage is overfilling of root canals (3). Termoplastic gutta-percha is hard to control in the periapical region.

Warm lateral condensation technique has been developed with a tendency to combine the advantages of cold lateral condensation technique and heat vertical condensation. Electrically warmed condenser, used in warm lateral condensation technique, enables warmed gutta-percha to become a more homogenous mass, closely fitted to canal walls. Obturation time is shorter for warm lateral condensation technique compared to heat vertical condensation, while uncontrolled source of high temperature is replaced by an electrically heated condenser (4). It holds constant temperature which assures better gutta-percha homogeneity with less voids.

The aim of this study was to examine microleakage of root canal fillings achieved with cold lateral condensation technique, Thermafil and Touch'n Heat techniques using standardised gutta-percha cones and RoekoSeal or AH Plus sealers.

Materials and methods

A sample of 66 one-rooted teeth was used for the experiment. After mechanical cleaning the teeth were sterilised in autoclave at a temperature of 120°C and 300 kPa pressure. The teeth were then stored in saline solution at 37°C.

The crowns were cut at the enamel-cementum junction with a cylindrical burr. Root canals were instrumented using "step-back" technique, rinsing with 2.5% water solution of NaOCl. Apical parts of the canals were instrumented up to # 40 K reamer, and coronary parts up to # 80 K reamer. External root surface of the coronary parts of the teeth was cylindrically shaped to obtain better fitting to plastic tube. After that the smear layer on the canal walls was treated for 60 seconds with etilendiamintetraacetatic acid. Next, canals were rinsed with water solution of 2.5% NaOCl, and dried with air and paper points.

Teeth were randomly divided into three groups, of 20 samples each. For the first sample group cold lateral condensation technique was used, for the second group Touch'n Heat, and the third group was treated with Thermafil technique.

Various types of gutta-percha were used as the filling material, depending on the obturation technique. RoekoSeal and AH Plus were used as sealers in 10 samples each for all tested techniques. The specimens were stored in 0.9% saline solution. After hardening of fillings during 48 hours the lateral surfaces of the teeth were coated with varnish and left to dry within 24 hours. Permeability of fillings was measured by the movement of the air bubble (5) during 5 minutes, using a stop-watch. As a control group 6 samples were used, from which 3 were tested as a positive and 3 as a negative control.

At three teeth in the positive control group canals were left empty. In the negative control group all surfaces of the roots including apices were coated with varnish, and the canals were obturated using one of the tested technique. After measurements the samples were stored in 0.9% saline solution and the test repeated after intervals of 6 and 12 months. Measurements were performed 4 times for each specimen and arithmetic mean values were recorded. The values were enclosed in the following formula:

$$v = \frac{\pi \times \Delta P \times r \times t}{8 \times L \times \eta}$$

P= pressure differences
r= capillary radius
t= fluid passing time
L= air bubble movement
η= fluid viscosity

In all cases the same implicated parameters were respected:

Pressure P= 1.2 atm (120 kPa)
Fluid passing time: 5 min
Radius of micropipette= 0.4768 mm

In this way, the values expressed in m/s were recorded and later changed to microliters (μL) in order to simplify the procedure.

From these results mean arithmetic values and standard deviations were calculated. Statistical analysis was performed using three-way variance analysis, with Scheffe "post hoc" test. The program "Statistica for Windows" (StatSoft, Tulsa, OK, USA) was used for all statistical calculations.

Results

Microleakage obtained with Thermafil technique was significantly greater compared to cold lateral condensation technique ($p < 0.05$).Touch'n Heat was not significantly different compared to the other two techniques.

There was no significant difference between RoekoSeal and AH Plus sealers with cold lateral condensation technique, Touch'n Heat and Thermafil technique for any tested interval. Results are presented in Figure 2.

No significant statistical difference was determined by comparing microleakage results after one month and after six months, as well as after 6 and 12 months. However, significant differences were obtained between results after one month and 12 months.

In the positive control group the air bubble movement was too fast to measure, while in the negative control samples no movement of the air bubble was obtained.

Discussion

Examination of obturation quality associated with different obturation techniques could be performed *in vitro*, using different methods. In this study, fluid transport system was used, recommended by Wu et al. (5) as a more sensitive technique compared to widely used dye penetration technique. In their investigation samples with certain microleakage were used. Test using fluid transport system showed 80% microleakage, while dye penetration test showed only 20% leakage (5). Using fluid transport technique gives certain advantages: there is no damage to the specimens because there is no need to cut or demineralize them, and results are more objective. In addition, it is possible to examine whether leakage is more or less r during a certain time period.

De Moore and Hommez (6) used dye penetration method for evaluation of leakage associated with cold lateral condensation technique, vertical condensation, gutta-percha hybrid condensation, Thermafil and Soft core obturators. They found rising apical and coronary microleakage for all tested techniques during different storing periods of canal fillings in a 4 month interval from canal obturation. For a 12 month interval greater leakage was found, associated with condensation techniques, coronary leaking always measured greater than apical. Respecting methodological differences, in this study greater leakage was also found, depending on time passed for the tested techniques. The minimum of leakage was measured one month after canal obturation, increasing during the first 6 month time period, while after one year all root canal fillings leaked significantly more compared to the one month interval.

In our study, the greatest microleakage was obtained using Thermafil technique, while minimum leaking was found using cold lateral condensation technique for all tested intervals. There was no significant statistical difference between Touch'n Heat to cold lateral condensation technique and Thermafil.

Bhambhani and Sprechman (7) noted gutta-percha contraction during transformation from α-phase into β-phase. Techniques based on termoplastic gutta-percha, with no vertical compaction included in the procedure, and techniques with heating of the apical part of gutta-percha at 45°C, are susceptible to gutta-percha contraction, no matter what type of gutta-percha was used (8). Indeed, results of this study could depend on the above mentioned contraction.

On the other hand, Gençoglu et al. (9) found Thermafil superior compared to cold lateral condensation technique. Da Silva et al. came to the same conclusion (3) using dye penetration method. Differences could be explained by the different methods of leakage examination.

Other factors that could affect microleakage as well as obturation technique are the characteristics of the used sealer. Sealer application is necessary for complete obturation of the canal space. It fills irregularity inside the endodontic space, small voids between gutta-percha and the canal walls and gives gutta-percha integrity. Often the sealer is pushed into the lateral and accessory canals, creating an antibacterial effect on the microorganisms in the dentin tubules (10). Depending on material composition, sealers are more or less soluble in tissue fluids (11). Sealers are also porous and a tendency to minimise

the quantity used during obturation procedure occurs in order to prevent leakage due to porosity and solubility. In this study, using the fluid transport system, equal obturated quality was found for AH Plus and RoekoSealer in combination with gutta-percha. Microleakage differences were not statistically significant for any tested obturation technique. However, in time both sealers become soluble and probably their characteristics also have an impact on microleakage after a long term storing period.

Finally, not one of the tested techniques was able to achieve hermetic obturation of root canal space during a longer time period, so it is essential to complete postendodontic treatment as quickly as possible.